VALVE STRUCTURE IN *MASTOGLOIA ROSTRATA* WITH A COMPARISON OF INTERCALARY BAND INTERNAL CONSTRUCTION IN TWO DISSIMILAR DIATOM SPECIES[1]

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ABSTRACT. — Internal valve structure of *Mastogloia rostrata, Climacosphenia moniligera* and *Diatomella salina* var. *brevistriata* was examined with the SEM. Intercalary septal bands were found in the three species and displayed similar basic characteristics. The septal bands of *M. rostrata* and *C. moniligera* possessed interdigitating cross septa at their minimum transapical dimensions. These cross septa were morphologically similar in these two species and judged simpler than those observed in *D. salina* var. *brevistriata*. The cross septa in the latter species differed in two respects : 1) they occurred near the maximum transapical dimension of the valve, and, 2) appeared as an interlocking joint. The functions of these internal cross septal connections were attributed to stability against mechanical forces.

RÉSUMÉ. — La structure des valves internes de *Mastogloia rostrata, Climacosphenia moniligera*, et *Diatomella salina* var. *brevistriata* a été examinée avec le microscope électronique à balayage. Des bandes septales intercalaires ont été trouvées dans les trois espèces, lesquelles montraient toutes des caractéristiques fondamentales semblables. Les bandes septales du *M. rostrata* et du *C. moniligera* possèdaient des septums transverses interdigités dans la partie la plus étroite de la valve. Ces septums transverses étaient semblables morphologiquement dans ces deux espèces, et plus simples que ceux observés dans *D. salina* var. *brevistriata*. Les septums transverses de cette espèce étaient différents à deux égards : 1) ils se situaient dans la partie la plus large de la valve, 2) ils ressemblaient à une jointure dont les parties s'enclenchent. Ce mode de connexion des septums transverses permettrait une meilleure résistance aux forces mécaniques.

KEY WORDS : Valve structure, intercalary band, *Mastogloia, Climacosphenia, Diatomella.*

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Plate 1 : Fig. 1-4 – *Mastogloia rostrata.* Fig. 1, light microscopy; Fig. 2-4, electron microscopy. Fig. 1, girdle view, scale : 10 µm. Fig. 2, girdle view showing locular pore (Lp), scale : 5 µm. Fig. 3, girdle view showing valve mantle, girdle and locular pore (Lp), scale : 1 µm. Fig. 4, girdle view of apical termination of raphe fissure (E), scale : 1 µm.

INTRODUCTION

The band containing septa or loculi (partecta) is the intercalary band found between the girdle and the valve (HUSTEDT, 1930; ROUND, 1972; von STOSCH, 1975). During cell morphogenesis this band is capable of inward growth (ROUND, 1972). The genus *Mastogloia* is characterized by the presence of such an intercalary band with inwardly projecting chambers (loculi, partecta). STEPHENS and GIBSON (1979) have shown that organic material originates from the external openings of these chambers in several *Mastogloia* species.

Mastogloia is one of the largest genera in the Bacillariophyceae with approximately 300 recognized epithets. The genus is predominately marine and with only two exceptions, epiphytic or epibenthic. One of these exceptions is *M. rostrata* (Wallich) Hust. This planktonic species is also unique in the genus because, in addition to the loculi, the intercalary band also possesses peculiar apical structures recognized by HUSTEDT (1933) as «openings».

Species of *Climacosphenia* also display these structures which MANN (1925) termed cross septa or «vittae». GERLOFF and HELMCKE (1977), ROUND (1982) and NAVARRO (1982) examined these in *C. moniligera* Ehr. with the SEM and confirmed that they were cross septa. ROUND (1982) also showed that these valvocopular cross septa possessed different connections, some complete and some interdigitate. These cross septa can be observed in a little known species of the naviculoid genus *Diatomella* as well. The purpose of this work was to examine and describe the structure of *M. rostrata* and to compare its cross septa with those of two other genera.

METHODS AND MATERIALS

Collections of various macroalgae were made in 1979 and 1980 during cruises of the R/V JOHNSON along the east Florida continental shelf in the vicinity of Palm Beach, Florida, USA. The samples were collected from the JOHNSON-SEA-LINK submersibles with hydraulic Petersen-type manipulator grab samplers and 12-place, rotating, self-sealing, plexiglas sample containers. Plankton samples were collected in the same area using a 0.5 m dia. conical ring net (30 μm mesh size) towed obliquely through the water column. All samples were immediately preserved upon collection in 5 % buffered formalin in 0.4 μm filtered seawater.

All material was digested using the technique described by SIMONSEN (1974). Cleaned diatom suspensions were dried onto 12 mm circular coverslips and either mounted in Hyrax (Custom Research and Development, Inc., 8500 Mt. Vernon Rd., Auburn, California) for observation with a Zeiss Universal TLM or mounted onto aluminium stubs with colloidal graphite and

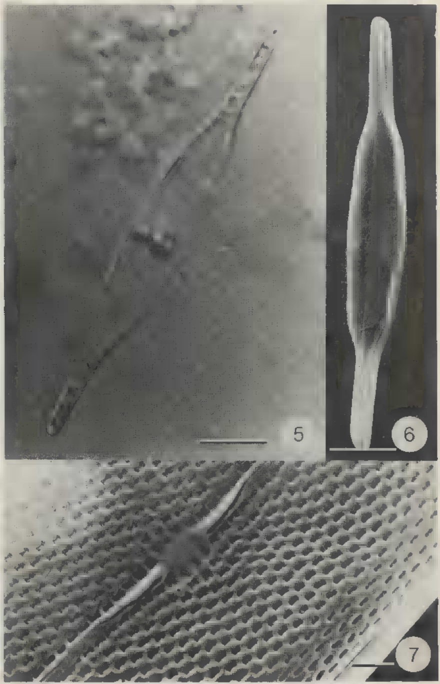

Plate 2 : Fig. 5-7 . — *Mastogloia rostrata.* Fig. 5, light microscopy; Fig. 6-7, electron microscopy. Fig. 5, valve view, scale: 10 µm. Fig. 6, valve view, scale : 10 µm. Fig. 7, valve view of central area, proximal ends of raphe fissures and puncta, scale : 1 µm.

sputter-coated with gold-palladium for examination with a Zeiss Novascan 30 SEM at an accelerating voltage of 15kv.

Terminology used is that found in HUSTEDT (1933) and ROSS et al. (1979).

RESULTS

Mastogloia rostrata (Wallich) Hust. in Rabh., Kryptog.-Fl. Deutschland 2 : 572. 1933. (family Naviculaceae, group Rostellatae).

— Light microscopy (Fig. 1, 5, 8). Valves are linear-lanceolate with extremely drawn-out or produced apices; length 55.2-75.2 µm, breadth 7.6-9.7 µm (HUSTEDT (1933) gives length as 75-95 µm and breadth 11-13 µm). Axial area is narrow and straight; central area unresolved. Transapical striae are straight and parallel throughout the valve face, 28-29 in 10 µm (HUSTEDT (ibid) gives ca. 30 in 10 µm); puncta unresolved. Intercalary band is with a pair of centrally-located, bead-shaped loculi (partecta) on either side of the valve; width 2.1-2.8 µm, length 2.8-3.4 µm. Loculi are evidently removed from the valve margin or, at least, positioned on an elongated supporting structure flush with the valve margin. The intercalary band is cross-connected by small septa at the apices.

— Electron microscopy, external girdle (Fig. 2-4). Puncta continue from the valve face and cover the valve mantle. Locular pores are removed toward the valve apices from parent loculi and positioned at the junction of the intercalary band and the valve mantle. Other components of the girdle are evidently structureless.

External valve face (Fig. 3, 4, 6, 7). Striae are decussate with the transapical rows straight and parallel. Puncta are small and consist of two small pores arranged parallel to the apical axis and separated by a small silicious band. The axial area is very narrow and encloses the nearly straight raphe fissures. Proximal raphe ends flex slightly in the same direction at the small central area. Distal raphe ends terminate at the valve apices [redacted] small lacriform expansions.

Internal valve face (Fig. 9-11). The internal basal structure consists of relatively heavy transverse ribs with less heavy longitudinal bands separating each puncta depression. Within these depressions are positioned the pair of small pores observed on the external valve face. The transverse ribs extend up to axial ribs which enclose the straight raphe fissures. Proximal raphe fissures stop at the central nodule and distal fissures end at terminal nodules. A pair of equal loculi lie on each side of the valve opposite the central nodule (not displaced from the central area as illustrated by HUSTEDT (1933)). The loculi are perforated by a few scattered locular puncta. The free margins of the loculi are convex, the attached side lying adjacent to what appears to be their respective locular tubes. These tubes are, in turn, attached to what is apparently a septate band which circumscribes the entire inner valve margin. This septum is cross-

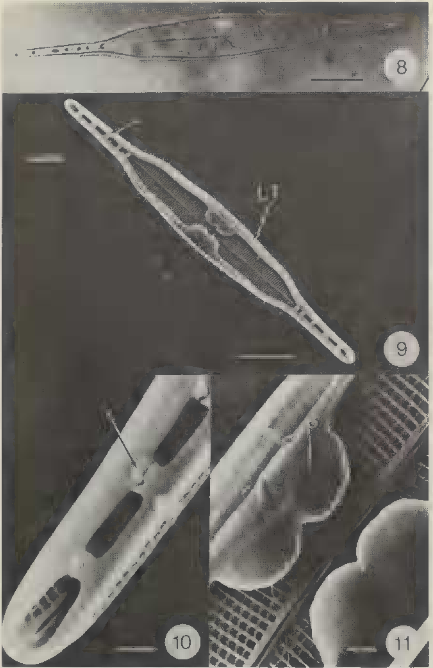

Plate 3 : Fig. 8-11. – *Mastogloia rostrata.* Fig. 8, light microscopy; Fig. 9-11, electron microscopy. Fig. 8, valve view with focus at locular level, scale : 10 µm. Fig. 9, internal valve view showing locular tubes (Lt) and septal cross-connections (arrow), scale : 10 µm. Fig. 10, internal valve view of apical end showing interdigitating cross-connections of septum (arrow), scale : 1 µm. Fig. 11, internal valve view of loculi with locular puncta (P), scale : 1 µm.

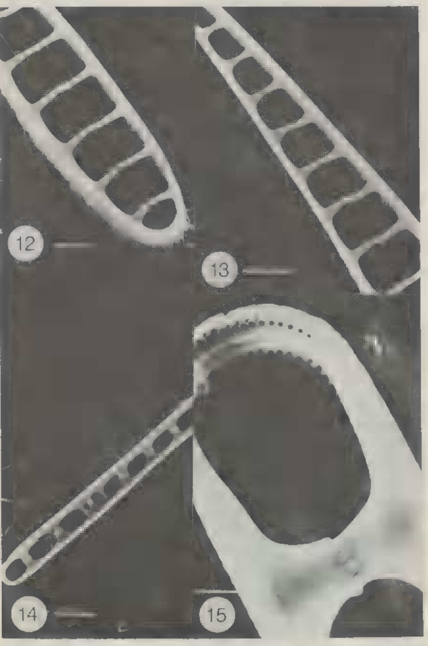

Plate 4 : Fig. 12-15. - *Climacosphenia moniligera*, electron microscopy. Fig. 12, internal valve view of headpole with septal cross-connections, scale : 10 μm. Fig. 13, internal view of midportion of valve showing septal cross-connections, scale : 10 μm. Fig. 14, internal valve view of footpole showing, interdigitating cross-connections, scale : 10 μm. Fig. 15, internal valve view of footpole showing an interdigitating cross-connection, scale : 2 μm.

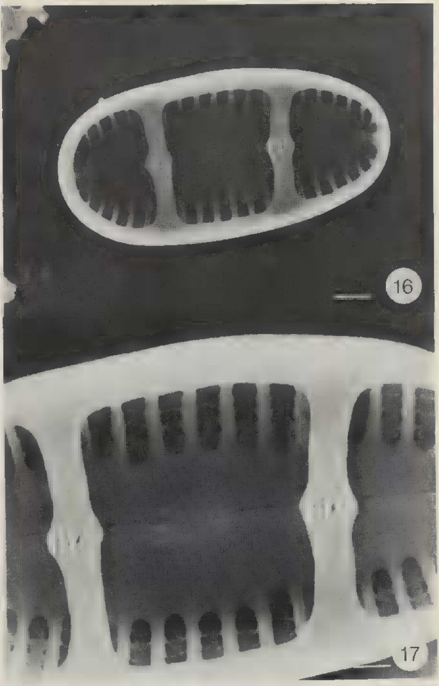

Plate 5 : Fig. 16-17. — *Diatomella salina* var. *brevistriata*, electron microscopy. Fig. 16, internal valve view, scale : 1 µm. Fig. 17, internal valve view showing interdigitating septal cross-connections, scale : 0.4 µm.

linked by several interinterdigitating bands across the rostrate portions of the valve.

– Distribution and ecology. *Mastogloia rostrata* is a holoplanktonic species found in most tropical-subtropical seas and oceans (Atlantic Ocean - MARSHALL (1976), Pacific Ocean - RICARD (1974), Indian Ocean - WALLICH (1860), Gulf of Mexico - SAUNDERS and GLENN (1969) and the Caribbean Sea - GRUNOW (1867)).

Climacosphenia moniligera Ehr., Abh. Berl.-Akad. p. 411. 1841. (family Naviculaceae).

– Electron microscopy (Fig. 12-15). Valves are clavate or club-shaped with head pole obtuse cuneate and footpole simply rounded (length 120-500 µm, breadth 15-40 µm at the headpole, ca. 10 µm at the footpole). The valve face has transapical rows of punctate striae which are more dense at the headpole than at the footpole. The striae are interrupted twice by apical hyaline area which extend the length of the valve. Most noticeable is the septate band which is crosslinked throughout the valve length. The cross-links are further apart at the headpole than at the footpole and appear to be fusions of silica at the headpole whereas they are interdigitating bands at the footpole.

– Distribution and ecology. *Climacosphenia moniligera* is an epiphytic or epibenthic species found in most tropical-subtropical seas and oceans.

Diatomella salina var. ***brevistriata*** Voigt, Rev. Algologique 2 : 69. 1957. (family Naviculaceae).

– Electron microscopy (Fig. 16-17). Valves are elliptical with broadly rounded apices (length 9.5-11 µm, breadth 3-4 µm). Transapical striae are formed of double rows of punctae which do not extend to the central raphe fissures. A septate band is present and the valve sides of this septum are crosslinked by two interdigitating structures.

– Distribution and ecology. This diminutive species, until now, was only known from the type locality in the Celebes Sea. It is evidently epiphytic or epibenthic on the east Florida continental shelf.

DISCUSSION

The three species described here are holoplanktonic (*M. rostrata)* and epiphytic or epibenthic *(C. moniligera* and *D. salina* var. *brevistriata). Mastogloia rostrata* and *M. woodiana* F. J.R. Taylor are the only known holoplanktonic species of the genus *Mastogloia.* These two species are very similar in appearance, particularly with respect to their locular (partectal) bands - see HUSTEDT

(1933) p. 571, fig. 1006 (as *M. capitata*; synonymy given in SIMONSEN, 1974, p. 40). However *M. woodiana* evidently does not possess the peculiar interdigitating structures. These structures then appear to be rather rare in pennate diatom internal valve structure.

CRAWFORD (1979 a & b) has shown examples of similar interdigitating structures which connect the external valves of adjacent frustules in *Melosira* and *Paralia* species. FRYXELL and MILLER (1978) have also shown similar structures to exist in some pennate species of *Delphineis*, *Glyphodesmis* and *Cymatosira*. The existence of specialized external spines in *Cymatosira* led to HASLE et al.'s (1983) treatment of this pennate group. The function of these external interdigitating processes is obviously to link cells together in a filamentous colony. A function for the internal structures observed in the three species examined here is certainly not that of colony formation.

KRAMMER (1981) has examined the valve structure of some Achnanthaceae and Naviculaceae. He found that the supporting elements of the valve (e. g. central costae, axial costae, end nodules) were structures which served to distribute stress strain and generally served as protection of the diatom cell. The internal interdigitating septal structures described here in *M. rostrata*, *C. moniligera* and *D. salina* var. *brevistriata* and in *D. hustedtii* Manguin and *D. ouenkoana* Maillard (LE COHU, 1983) would also appear to serve as a mechanical support or brace for the valve. It can be observed from Figures 10, 15 and 17 that two types of structures exist in these species. The first is simply a convoluted joining of the opposing bands. This type is observed at the apices of *M. rostrata* and at the footpole of *C. moniligera*. It should also be noted that the location of this type of structure occurs along the minimum transapical dimension of the valves, an area of possible weakness. Conversely, the second type is observed as an interlocking joint of the opposing bands in *D. salina* var. *brevistriata*. This diatom is more robust in its transapical dimension than either of the other species. This might imply that the two structural types of interdigitation function as supports or braces against different mechanical forces. These forces may be compression, expansion or torsion. The first type, that of a simple joining of opposing bands, could brace the valve against compressional forces or perhaps even torsional forces. However it would not prevent expansion of the valve as observed in the separation of the interdigitations in Figure 10, presumably caused by heating by the electron beam or during the cleaning process. Alternatively, the second, more secure, interlocking type observed in *D. salina* var. *brevistriata* would protect the valve from all the forces mentioned above. These internal structures appear then to be somewhat homologous and perhaps analogous to external structures observed in both the pennate and centric lines.

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